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ERNEST BROWN BABCOCK

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A Biographical Memoir by
G. LEYDARD STEBBINS

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E. B. Babcock

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BY G. LEDYARD STEBBINS

AS A SCHOLAR who saw clearly the valuable contributions which his chosen field could make to other branches of knowledge, both theoretical and applied, Ernest Brown Babcock played a significant role in the development of the science of genetics. He became a pioneer in exploring some of these extensions of genetics. Many of the foremost geneticists and plant breeders of our times received their early training through a study of the book, *Genetics in Relation to Agriculture,* which he wrote in collaboration with his colleague, R. E. Clausen. His monumental monograph of the genus *Crepis* remains to this date the foremost attempt to explain the evolution of a genus of plants primarily on a genetic basis, while considering at the time all other possible avenues of approach.

Babcock was born at Edgerton, Wisconsin, on July 10, 1877, the son of Emilius Welcome and Mary Eliza (Brown) Babcock. He received his early education in Wisconsin, and it was there that he acquired the fondness for and curiosity about the beauties of the plant world which spurred him on to his career. When he was in his teens, his parents spent a winter in California, leaving young Ernest in charge of his mother's conservatory. Here he became curious about plant forms, and, as a result, started a home flower garden. The sweet peas in this garden attracted his interest and, by scanning seedsmen's catalogues, he acquired many unusual new varieties which had just been created. Since he did more than admire these novelties, but began to wonder how and why they came to differ from each

other, his interest in his chosen field of science was born at that time.

During his first year of higher education at Lawrence College in Appleton, Babcock took many botanizing trips along the Fox River, and there became interested in wild plants, the second of the two interests which he was later to unite so successfully into a concerted attack on the mysteries of plant evolution. The following year, however, he moved with his family to California, where he attended normal school for two years and taught grammar scool for three more. During this time, his only contact with his chosen field of plant science was during the summer of 1900, when he served as cook and packer on a three months' camping trip in the high Sierra Nevada with two other college students, Harvey M. Hall and Harley P. Chandler. This trip began a lifelong friendship for the three men, all of whom became plant scientists on the staff of the University of California. The enthusiasm of Hall and Chandler for studying the native flora made a deep impression on Babcock, and did much to direct his later interest in genetics toward a study of wild plants and their evolution.

Finally, in 1901, Babcock's earnings as a teacher had made financially possible his entrance into the career which he desired, that of a plant breeder. Before entering the College of Agriculture of the University of California, he went to Luther Burbank to ask his advice about the value of a university course for a prospective plant breeder. This genial sage did not deny the possible value of such training, but emphasized to Babcock the importance of becoming well acquainted with plants which he was going to breed. Babcock never forgot this admonition.

Having entered the University, he found that no instruction in plant breeding was offered there. He therefore took the prescribed curriculum in agriculture, adding to it as many courses of botany as possible. In the summer of 1903 Hugo De Vries, one of the rediscoverers of Mendel's laws and the author of the mutation theory of evolution, visited the University of California. His lectures, though

difficult to understand, stimulated Babcock's interest in the study of evolution.

Upon graduating from college, Babcock devoted his attention for eight years to the teaching of agriculture and to experiment station work, only part of which was in plant breeding. In 1907 he began his first project in plant breeding, at the newly formed Citrus Experiment Station in southern California. The raising of peaches in that section of the country was hazardous, because in most years the winter chilling is not enough to bring about the right conditions of dormancy in commercial peach varieties, and thus to enable them to respond to spring temperatures by uniform flowering and leafing. Babcock noticed that a Chinese peach variety with very inferior fruit was an exception to this rule, and performed consistently well under southern California conditions. He therefore set about combining this desirable growth rhythm with good fruit quality by crossing this Chinese variety with the well-known commercial variety Elberta. Babcock left his position at Riverside before the experiment was finished, but his successors selected from the progeny of his cross a variety with good quality and consistent performance in southern California, which they named after him.

In 1908, Babcock married Georgia Bowen, a childhood friend and neighbor from Edgerton, Wisconsin. In the same year, he joined the faculty of the University of California at Berkeley, where he remained until his retirement in 1947. In his new position, he began an investigation of a curious form of the California black walnut, whose leaves bore a superficial resemblance to those of the California live oak, and eventually demonstrated that it was a spontaneous mutation.

In 1913, Thomas Forsyth Hunt became Dean of the College of Agriculture, and undertook a complete reorganization of its curriculum. He asked Babcock to take charge of one of four basic courses of the new curriculum, namely, the principles of plant and animal breeding. As a result, Babcock organized the Division of Genetics, one of the first departments of its kind in the country. He was made

Professor of Genetics and head of the division, a position which he held for thirty-four years until his retirement in 1947.

Babcock had thus achieved his early expressed desire to become a plant breeder. Furthermore, he entered into the new science of genetics in the middle of the golden age of its development, when the spectacular discoveries of T. H. Morgan and his coworkers were convincing the biological world of the general validity and immense importance of the chromosomal theory of heredity. Babcock first devoted his attention to the difficult problem of teaching these new discoveries in terms of their significance to practical problems of plant and animal breeding. In 1914, he added to his department a brilliant young instructor R. E. Clausen, who was associated with him throughout the rest of his life, and who succeeded him as head of the Department of Genetics. Together, they produced a textbook, *Genetics in Relation to Agriculture,* the first in its field. As soon as it appeared in 1918, this text became immediately popular, and during the 1920s and '30s it was one of the most widely used of genetics textbooks. A second, greatly expanded edition, appeared in 1927.

When his teaching program had become well established, Babcock began to look around for suitable material with which to begin a long term program of research in plant genetics. He believed that, although the impressive conclusions reached by the *Drosophila* workers were almost certainly applicable in their essential features to all animals and plants, corroborative evidence should be obtained from other organisms before they could be considered as firmly established. Since the success of the *Drosophila* research depended partly upon the fact that this fly has a low chromosome number, Babcock's attention was attracted by a plant genus which also had been found to contain species with only six chromosomes. This was *Crepis,* a small weedy relative of the dandelion. In addition, he found that the species of *Crepis* are easy to raise in the greenhouse, have a short life cycle, and can be hybridized without great difficulty. Moreover, the genus contains a large number of species with very diverse characteristics. Consequently, he reasoned that in *Crepis* the geneti-

cist could study not only the properties of a single genetic system, but in addition the relationships between different systems. This, he concluded, would provide fundamental evidence concerning the nature of the processes of evolution.

In 1918, he formed a research team of three workers: J. L. Collins, who did most of the breeding work, Margaret C. Mann (later Mrs. J. W. Lesley), who carried out the first cytological studies, and himself as taxonomist and general planner. This group brought together a number of species, began interspecific hybridization, and studied certain individual genetic characteristics particularly in *C. capillaris.* After a few years, they realized that for various reasons *Crepis* could not be used for chromosome mapping studies like those of the Morgan school in *Drosophila,* but that it was, nevertheless, favorable material for studying interspecific relationships from the cytological and genetic point of view. After 1925, therefore, the research on *Crepis* was directed almost entirely toward obtaining evidence from cytology and genetics to supplement that from external morphology regarding the interrelationships of species. His original associates, Collins and Mann, were followed by a series of coworkers and students, some of whom were well known before their sojourn at Berkeley, and others later became eminent cytogeneticists in their own right. Among them were Lillian Hollingshead, Jens Clausen, M. S. Navashin, A. Müntzing, D. R. Cameron, J. A. Jenkins, S. L. Emsweller, and M. S. Walters. The investigations carried on in collaboration with these workers established a series of basic facts about the evolution of species in the genus. Species differentiation was found to involve three different kinds of genetic changes: gene mutations; structural changes of the chromosomes, which sometimes caused alterations in the basic chromosome number; and polyploidy. The latter phenomenon was found only in a few groups. Furthermore, certain definite phylogenetic trends were discovered in the somatic chromosomes, particularly reduction in size and basic number in association with the evolution of the annual habit of growth. These findings were reported in a number of publications, particularly a

partial monographic study of *Crepis* by Babcock and Navashin in *Bibliographica Genetica* for 1930, and were summarized in a display of the phylogeny of *Crepis,* illustrated by living plants, and presented at the Sixth International Congress of Genetics at Ithaca in 1932. In 1930, Babcock made an extensive tour of the Mediterranean region, becoming familiar with many species of *Crepis* under natural conditions, and augmenting greatly his collection of living material.

After he had studied living material of more than half of the species, he realized that he could not understand fully the evolution of this genus unless he also learned something about the genera related to it. In 1935, therefore, aided by grants from the Carnegie Institution of Washington and the Rockefeller Foundation, he began a collaboration with G. L. Stebbins and J. A. Jenkins with this in mind. A cytological survey of these related genera was followed by a monographic study of one of them, *Youngia,* and a series of shorter studies on others. As a result, the limits of the genus *Crepis* became sharply defined, and its position in the tribe Cichorieae of the family Compositae was accurately determined. A byproduct of this collaboration was an intensive study of the North American species of *Crepis,* which was presented as a model for the systematic treatment of plant genera characterized by the presence of both polyploidy and asexual or apomictical reproduction.

During the last few years before his retirement, Babcock worked intensively on the final stages of his *Crepis* monograph. He arranged the species into sections, and worked out a phylogenetic scheme for the relationships between them; he compiled the data on chromosome numbers and morphology, crossability, and chromosome behavior in the hybrids, and geographic distribution; and he made a careful and comprehensive study of the historical geology, paleontology, and plant geography of Eurasia. As a result of this study, and of his ability to synthesize and to see the relationships between the facts which he had assembled, he was able to put together a coherent and logical account of the origin, evolution, and migration of the 196 species of *Crepis* which he recognized. This was the first attempt of

a botanist to explain the evolution of such a large number of species on the basis of such a large body and wide range of types of evidence; and Babcock's *Crepis* monograph still remains unique in this respect.

Published in 1947, his year of retirement, by the University of California Press, the monograph was recognized at once by botanists as a milestone in the progress of plant systematics and evolution. Its breadth of scope attracted the attention of many botanists working in these fields, while its accuracy, clarity, and careful attention to detail brought forth the commendations of specialists on the various floras in which *Crepis* is native. It was the crowning achievement of one of the most eminent students of plant evolution of his generation.

Babcock's work did not end with his retirement. He first occupied himself with compiling a brief history of the science of genetics, much of which he had followed during his lifetime. This was accompanied by a study with his last graduate student, M. B. Hughes, on self incompatibility in *Crepis foetida,* as a result of which a new type of genetic determination for self sterility was established.

Finally, he turned his attention to the application of genetics toward replenishing our decreasing resources of forest products. Since 1932, he had been an adviser of the Institute of Forest Genetics at Placerville, California, and had taken an active interest in its work. During much of this time the Institute had been an "orphan" of the Forest Service, receiving totally inadequate support, and continuing to make valuable contributions only because of the dedicated service of a few research workers. In 1950, Babcock, along with Dr. F. I. Righter, Director of the Institute, aroused the interest of S. N. Wyckoff, a former director of the California Forest and Range Experiment Station. Together they formed the Forest Genetics Research Foundation, and assembled a board of sponsors which included most of the eminent geneticists of the nation. This approach bore the expected results, and by the first part of 1954 the Institute of Forest Genetics had received from Congress a greatly increased appropriation. His final paper, "Future Forests and Heredity," which appeared

in the journal *American Forests,* did much to stimulate the now active interest in the application of genetic science to tree breeding. The fact that his final work was directed toward helping some of his fellow geneticists to overcome their difficulties, and toward helping to increase natural resources which will be required by future generations, illustrates at the same time the affection for his fellow men and the far-sighted altruism which were the outstanding personal characteristics of Ernest Babcock.

He was elected to the National Academy of Sciences in 1946, and held office in numerous professional societies. He was President of the Western Society of Naturalists in 1929, of the California Botanical Society in 1940, of the Society for the Study of Evolution in 1952, and of the California Academy of Sciences in 1954. He was Vice President of the American Society of Naturalists in 1934, and Associate Secretary Pacific Division, A.A.A.S., in 1952. The University of California honored him with its Faculty Research Lectureship in 1944, and with the degree of LL.D. in 1950.

To those who knew him casually or intimately, Ernest Babcock was much more than an eminent scientist. He was one of those rare personalities whose kindliness and affection for his fellow men dominated his whole nature. He was particularly interested in students or fellow scientists who needed assistance of any kind. Through his help, a large number of students, particularly from foreign countries, were able to complete their higher education, and several older and well-known scientists obtained better opportunities for work or more congenial surroundings for their years of retirement. Ernest Babcock's abiding faith in the goodness of mankind and his cheerful outlook toward life gained him the friendship and affection of a large circle of his fellow men.

KEY TO ABBREVIATIONS

Amer. Nat. = American Naturalist
Calif. Agr. Expt. Sta. Cir. = California Agricultural Experiment Station Circular
Carnegie Inst. Wash. Yearbook = Carnegie Institution of Washington Yearbook
Jour. Bot. = Journal of Botany (British)
Jour. Hered. = Journal of Heredity
Proc. Nat. Acad. Sci. = Proceedings, National Academy of Sciences
Univ. Calif. Jour. Agr. = University of California Journal of Agriculture
Univ. Calif. Publ. Agr. Sci. = University of California Publications in Agricultural Science
Univ. Calif. Publ. Bot. = University of California Publications in Botany

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